

Patented Inventions

New technical inventions have important economic benefits to a nation, because they can often lead to innovations in new or improved products or more efficient manufacturing processes—or even to new industries. To foster inventive activity, nations assign property rights to inventors in the form of patents, which allow the inventor to exclude others from making, using, or selling the invention. Inventors can obtain patents from government-authorized agencies for inventions judged to be new, useful, and nonobvious.

Patent data provide useful indicators of technical change and serve as a means of measuring inventive output over time.¹² Further, U.S. patenting by foreign inventors enables measurement of the levels of invention in those foreign countries (Pavitt 1985) and can serve as a leading indicator of new technological competition (Faust 1984). Patenting trends can therefore serve as an indicator—albeit one with certain limitations—of national inventive activities.¹³

This section describes broad trends in inventive activity in the United States over time by national origin of owner, patent office class, patent activity, and commerce activity.

U.S. Patenting

In 1998, nearly 148,000 patents were issued in the United States. This record number of new inventions resulting in new patents capped off what had been years of increases since 1990. In 1995, U.S. patents granted fell short of the previous year's mark, but not by much. The upward trend resumed with small increases in U.S. patents granted in 1996 and 1997 before a 32 percent jump in 1998. (See appendix table 7-15.)¹⁴

Patents Granted to U.S. Inventors

During the 1980s, the number of U.S. patents awarded to U.S. inventors began to decline just as the number awarded to foreign inventors began to rise. This of course raised questions about U.S. inventive activity and whether these numbers were yet another indicator of U.S. competitiveness on the decline. By the end of the decade, however, U.S. inventor

patenting picked up and continued to increase and outpace foreign inventor patenting in the United States. This trend has continued during the 1990s. Rising nearly every year since 1990, U.S. inventors were awarded more than 61,000 new patents in 1996 and more than 80,000 patents in 1998. (See figure 7-21.)

Inventors who work for private companies or the Federal Government commonly assign ownership of their patents to their employers; self-employed inventors typically retain ownership of their patents. Examining patent data by owner's sector of employment can therefore provide a good indication of the sector in which the inventive work was done. In 1998, 79 percent of U.S. owned patents were owned by corporations. (See the sidebar, "Top Patenting Corporations.")¹⁵ This percentage has increased gradually over the years.¹⁶

After business entities, individuals are the next largest group of U.S. patent owners. Prior to 1985, individuals owned, on average, 24 percent of all U.S. owned patents.¹⁷ Their share has fluctuated downward since then. In 1998, the share accounted for by individuals dropped to its lowest point—20 percent. The Federal share of patents averaged 3.3 percent of the total during the period 1963–84. Thereafter, U.S. Government-owned patents as a share of total U.S. origin patents declined.¹⁸ U.S. Government-owned patents were encouraged

¹⁵About 5 percent of U.S. patents granted to U.S. inventors in 1998 were owned by U.S. universities and colleges. The U.S. Patent and Trademark Office counts these as being owned by corporations. For further discussion of academic patenting, see chapter 6, "Academic Research and Development: Financial and Personnel Resources, Support for Graduate Education, and Outputs."

¹⁶From 1985 to 1995, corporate-owned patents accounted for between 73 and 76 percent of total United States–owned patents. Since then, corporations increased their share each year and represented 79 percent of total United States–owned patents in 1998.

¹⁷Prior to 1985, data are provided as a total for the period 1963–84.

¹⁸Federal inventors frequently obtain a statutory invention registration (SIR) rather than a patent. An SIR is not ordinarily subject to examination, and it costs less to obtain than a patent. Also, an SIR gives the holder the right to use the invention, but does not prevent others from selling or using it as well.

¹²See Griliches (1990) for a survey of literature related to this point.

¹³Although the U.S. Patent and Trademark Office grants several types of patents, this discussion is limited to utility patents only, which are commonly known as "patents for inventions." Patenting indicators have several well-known drawbacks, including the following:

- ♦ *Incompleteness*—many inventions are not patented at all, in part because laws in some countries already provide for the protection of industrial trade secrets.

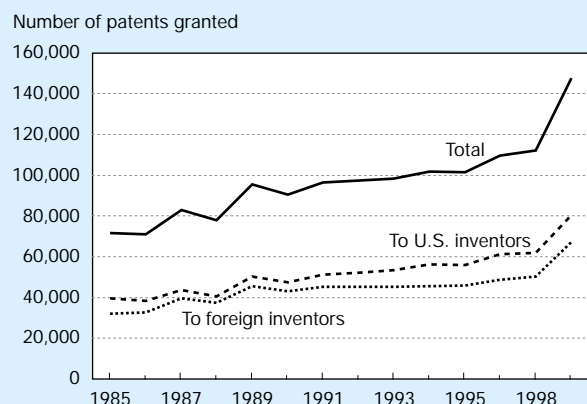
- ♦ *Inconsistency across industries and fields*—industries and fields vary considerably in their propensity to patent inventions and, consequently, it is not advisable to compare patenting rates among different industries or fields (Scherer 1992).

- ♦ *Inconsistency in quality*—the importance of patented inventions can vary considerably.

Despite these and other limitations, patents provide a unique source of information on inventive activities.

¹⁴Although patent applications have been rising, the U.S. Patent and Trademark Office attributes most of the increase in 1998 to greater administrative efficiency and the hiring of additional patent examiners.

Figure 7-21.
U.S. patents granted, by nationality of inventor



See appendix table 7-12. *Science & Engineering Indicators – 2000*

Top Patenting Corporations

An examination of the top patenting corporations in the United States over the past 25 years illustrates the rapid technological transformation achieved by Japan during a relatively short period. In 1973, no Japanese companies were among the top 10 patenting corporations in the United States. In 1983, three Japanese companies were among the top 10. By 1993, Japanese companies outnumbered U.S. companies, and data for 1996 show 7 Japanese companies among the top 10. The most recent data (1998) now show 1 South Korean company among the top 10—3 U.S. companies, and 6 Japanese companies. (See text table 7-4.) Similar to Japan's, Korea's U.S. patenting now emphasizes computer technologies, television and communications technologies, and power generation technologies. Despite their economic problems, Korea's and Japan's continued success patenting inventions in the United States indicates a growing capacity for innovation in important technologies.

Text table 7-4.

Top patenting corporations

Company	Number of patents
In 1998	
International Business Machines Corp.	2,657
Canon Kabushiki Kaisha	1,928
NEC Corporation	1,627
Motorola Inc.	1,406
Sony Corporation	1,316
Samsung Electronics Co., Ltd	1,304
Fujitsu Limited	1,189
Toshiba Corporation	1,170
Eastman Kodak Company	1,124
Hitachi, Ltd	1,094
From 1977-96	
General Electric Corp.	16,206
International Business Machines Corp.	15,205
Hitachi, Ltd	14,500
Canon Kabushiki Kaisha	13,797
Toshiba Corporation	13,413
Mitsubishi Denki Kabushiki Kaisha	10,192
U.S. Philips Corporation	9,943
Eastman Kodak Company	9,729
AT&T Corporation	9,380
Motorola Inc.	9,143

SOURCE: U.S. Patent and Trademark Office, Office of Information Systems, TAF Program.

Science & Engineering Indicators – 2000

by legislation enacted during the 1980s which called for U.S. agencies to establish new programs and increase incentives to their scientists, engineers, and technicians that would facilitate the transfer of technology developed in the course of government activities.¹⁹

Patents Granted to Foreign Inventors

Foreign-origin patents represent nearly half (46 percent in 1998) of all patents granted in the United States.²⁰ Their share rose throughout most of the 1980s before edging downward in 1989. At their peak in 1988, foreign-origin patents accounted for 48 percent of total U.S. patents. The following year and up until 1996, U.S. inventor patenting increased at a faster pace than that by foreign inventors, dropping the foreign share to 44 percent. Both U.S. and foreign patenting picked up in 1997 and 1998.

Foreign patenting in the United States is highly concentrated by country of origin. In 1998, two countries—Japan and Germany—accounted for nearly 60 percent of U.S. patents granted to foreign inventors. The top four countries—Japan, Germany, France, and the United Kingdom—accounted for about 70 percent. (See figure 7-22.)

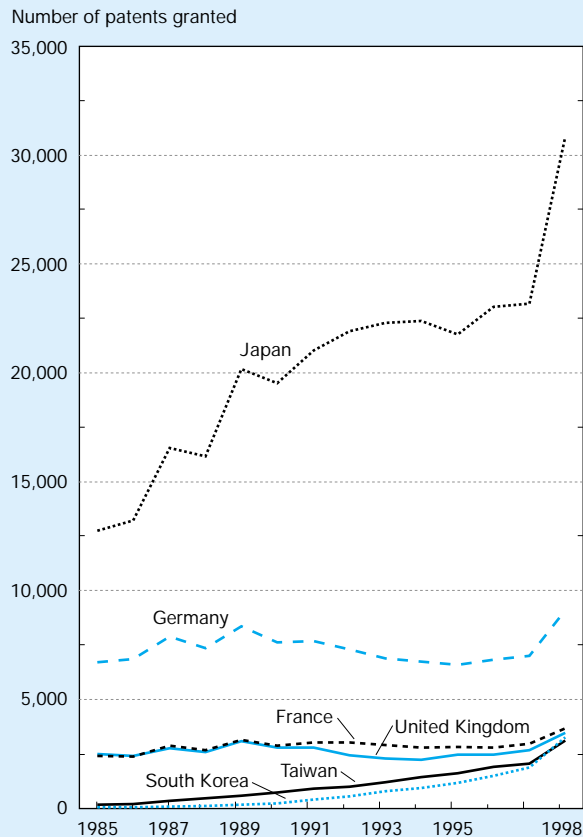
While patenting by inventors from the leading industrial countries has leveled off and has even begun to decline in some instances other economies, particularly Asian economies outside Japan, have stepped up their patenting activity in the United States and are showing themselves to be strong inventors of new technologies.²¹ This is especially true for Taiwan and South Korea. Before 1985 (data are available starting in 1963), Taiwan was awarded just 568 U.S. patents. Between 1985 and 1995, Taiwan was awarded nearly 9,000 U.S. patents. During the next three years, Taiwan was awarded another 7,000 U.S. patents. U.S. patenting activity by inventors from South Korea shows a similar growth pattern. Before 1985, South Korea was awarded just 172 U.S. patents. Since then, more than 11,000 new patents have been awarded. In 1998, South Korea was awarded more patents than Taiwan, and both countries surpassed Canada to become the fifth and sixth most active foreign inventors in the United States. Sweden and the Netherlands are two other countries awarded more than 1,000 patents and showing large increases in U.S. patenting in 1998.

¹⁹The Stevenson-Wydler Technology Innovation Act of 1980 made the transfer of federally owned or originated technology to state and local governments and to the private sector a national policy and the duty of government laboratories. The act was amended by the Federal Technology Transfer Act of 1986 to provide additional incentives for the transfer and commercialization of federally developed technologies. Later, Executive Order 12591 of April 1987 ordered executive departments and agencies to encourage and facilitate collaborations among federal laboratories, state and local governments, universities, and the private sector—particularly small business—to aid technology transfer to the marketplace. In 1996, Congress strengthened private sector rights to intellectual property resulting from these partnerships.

²⁰Corporations account for about 90 percent of all foreign-owned U.S. patents in 1998.

²¹Some of the decline in U.S. patenting by inventors from the leading industrial nations may be attributed to the move toward European unification, which has encouraged wider patenting within Europe.

Figure 7-22.
U.S. patents granted to foreign inventors,
by nationality of inventor



NOTE: Selected countries are the top six recipients of U.S. patents during 1998.

See appendix table 7-12. *Science & Engineering Indicators – 2000*

Technical Fields Favored by Foreign Inventors

A country's distribution of patents by technical area has proved to be a reliable indicator of a nation's technological strengths, as well as an indicator of direction in product development. This section compares and discusses the various key technical fields favored by inventors in the world's three leading economies—the United States, Japan, and Germany—and in two newly industrialized economies—Taiwan and South Korea.²²

²²Information in this section is based on the U.S. Patent and Trademark Office's classification system, which divides patents into approximately 370 active classes. With this system, patent activity for U.S. and foreign inventors in recent years can be compared by developing an activity index. For any year, the activity index is the proportion of patents in a particular class granted to inventors in a specific country divided by the proportion of all patents granted to inventors in that country. Because U.S. patenting data reflect a much larger share of patenting by individuals without corporate or government affiliation than do data on foreign patenting, only patents granted to corporations are used to construct the U.S. patenting activity indices.

Fields Favored by U.S., Japanese, and German Inventors

While U.S. patent activity spans a wide spectrum of technology and new product areas, the patenting of U.S. corporations shows a particular emphasis on several of the technology areas that are expected to play an important role in future economic growth. (See U.S. OSTP 1997, pp. 5–9.) In 1997, corporate patent activity reflected U.S. technological strengths in developing new medical and surgical devices, electronics, telecommunications, advanced materials, and biotechnology. (See text table 7-5.)

The 1997 patent data continue to show Japanese inventors emphasizing technology classes associated with photography, office machines, and consumer electronics industries. What is also evident in 1997 is the broader range of U.S. patents awarded to Japanese inventors in information technology. From improved information storage technology for computers to visual display systems, Japanese inventions are earning U.S. patents in areas that aid the processing, storage, and transmission of information.

German inventors continue to develop new products and processes in technology areas associated with heavy manufacturing industries in which that country has traditionally maintained a strong presence. The 1997 U.S. patent activity index shows a German emphasis on motor vehicles, printing, new chemistry and advanced materials, and material handling equipment-related patent classes.

Fields Favored by Two Newly Industrialized Economies

Patent activity in the United States by inventors from foreign countries can be used to identify a country's technological strengths and is also seen as a leading indicator of U.S. product markets likely to see increased competition.

As recently as 1980, Taiwan's U.S. patent activity was primarily in the area of toys and other amusement devices. By the 1990s, Taiwan was active in such areas as communications technology, semiconductor manufacturing processes, and internal combustion engines. The latest available data (1997) show that inventors from Taiwan have continued to patent heavily in processes used in the manufacture of semiconductor devices. They also show heavy activity in computer storage and display devices, advanced materials, and transistors. (See text table 7-6.) Ten years earlier, inventors from Taiwan received only 1 patent in any of these technology classes.

U.S. patenting by South Korean inventors has also shown rapid technological development. The 1997 data show that Korean inventors are patenting heavily in television technologies and a broad array of computer technologies that include devices for dynamic and static information storage, data generation and conversion, error detection, and display systems. (See text table 7-6.)

Both South Korea and Taiwan are already major suppliers of computers and peripherals to the United States. The recent patenting data show that their scientists and engineers are

continuing to develop the new technologies and improve existing technologies. It is likely that these new inventions will enhance their competitiveness in the United States and global markets.

Patenting Outside the United States

In most parts of the world, foreign inventors account for a much larger share of total patent activity than is the case in the United States. When foreign patent activity in the United States is compared with that in 11 other important countries in 1985, 1990, and again in 1996, only Russia and Japan had less foreign patent activity. (See figure 7-23 and appendix table 7-13.)

What is often obscured by the rising numbers in foreign-origin patents in the United States is the success and widespread activity of U.S. inventors in patenting their inventions around the world. In 1996, U.S. inventors led all other foreign inventors not just in countries neighboring the United States, but also in distant and diverse markets, such as Japan, France, Italy, Brazil, India, Malaysia, and Thailand. (See figure 7-24.) Japanese inventors edge out Americans in Germany and dominate foreign patenting in South Korea. German inventors lead all foreign inventors in Russia; they are also quite active in many of the other countries examined.

Venture Capital and High-Technology Enterprise

One of the most serious challenges to new entrepreneurs in the innovation process is capital—or the lack thereof. Venture capitalists typically make investments in small, young companies that may not have access to public or credit-oriented institutional funding. Venture capital investments can be long term and high risk, and may include hands-on involvement by the venture capitalist in the firm. Venture capital thus can aid the growth of promising small companies and facilitate the introduction of new products and technologies, and is an important source of funds used in the formation and expansion of small high-technology companies. This section examines investments made by U.S. venture capital firms, by stage of financing and by technology area.

The pool of capital managed by venture capital firms grew dramatically during the 1980s as venture capital emerged as a truly important source of financing for small innovative firms. (See text table 7-7.) By 1989, the capital managed by venture capital firms totaled \$33.5 billion, up from an estimated \$4.1 billion in 1980. The number of venture capital firms also grew during the 1980s—from around 448 in 1983 to 670 in 1989.

In the early 1990s, the venture capital industry experienced

Text table 7-5.

Top 15 most emphasized U.S. patent classes for corporations from the United States, Japan, and Germany: 1997

United States	Japan	Germany
1. Surgical Instruments	Photography	Printing
2. Biology of multicellular organisms	Information storage and retrieval	Plant protecting and regulating compositions
3. Surgery: light, thermal, and electrical applications	Electrophotography	Clutches and power-stop control
4. Surgery: application, storage, and collection	Liquid crystal cells	X-ray or gamma ray devices
5. Prosthesis	Facsimile	Organic compounds (includes classes 532–570)
6. Computers and digital processing	Typewriting machines	Fabrication of plastics and earthenware
7. Data processing	Television signal processing	Machine element or mechanism
8. Special receptacle or package	Printing of symbolic information	Winding, tensioning, or guiding devices
9. Telephone communications	Optics: systems and element	Metal deforming
10. Communications: Directive radio wave systems	Active solid-state devices	Internal combustion engines
11. Chemistry: Molecular biology and microbiology	Radiation imagery chemistry	Coating or plastic fabrication
12. Chemistry: Natural resins or derivatives	Storage or retrieval of magnetic information	Paper making
13. Information processing system organization	Internal-combustion engines	Power-driven conveyors
14. Cryptography	Television	Sheet feeding or delivering
15. Chemistry: analytical and immunological testing	Electrical generator or motors	Synthetic resins or natural rubbers

NOTE: Ranking is based on patenting activity of nongovernment U.S. or foreign organizations, which are predominantly corporations. Patenting by individuals and governments is excluded.

SOURCE: U.S. Patent and Trademark Office, Office of Information Systems, TAF Program.